APPENDIX D. North Carolina Migratory Shorebird Microhabitat Availability in 1998

Color infrared orthophoto one-quarter quadrangle images, in digital format, taken of eastern North Carolina by the U.S. Geological Survey (USGS) in 1998 were analyzed for six migratory shorebird and waterbird microhabitat types. The study area started at the Virginia-North Carolina boundary in the north and proceeded south to Hog Inlet, the first tidal inlet entirely within South Carolina.

The six microhabitats were defined as bare sand areas with differing hydrologic and geomorphic characteristics. The microhabitat categories and remote survey methodology were reviewed by a group of ornithologists and technical experts at the 2002 Piping Plover, Southern Recovery Unit, Meeting held in Chincoteague, Virginia, in January. A brief summary of each microhabitat is summarized below.

(1) *wet inlet shoulder*. These areas are intertidal in nature and occur along the shorelines immediately adjacent to tidal inlets. This microhabitat represents a foraging habitat with an infaunal community dominated by polychaete worms and amphipods. Only inlets open in 1998 were evaluated.

(2) *dry inlet shoulder*. Immediately adjacent to wet inlet shoulder microhabitats, these areas occur above the visible wet-dry line and represent nesting, roosting and loafing habitat. Dry inlet shoulder areas ceased to exist where vegetation became more than sparse.

(3) *ebb tidal shoal*. Sandy shoal areas within the ebb tidal delta of inlets that were interpreted as emergent at mean low water (intertidal) or shallow enough for use by wading birds were categorized as ebb tidal shoals. Water depths for consideration were less than one foot and were interpreted by best professional judgement. Ebb and flood tidal shoals represent staging areas for migrating flocks, roosting and foraging areas.

(4) *flood tidal shoal*. Sandy shoal areas within the flood tidal delta of inlets that were interpreted as emergent at mean low water (intertidal) or shallow enough for use by wading birds were categorized as flood tidal shoals. Water depths for consideration were less than one foot and were interpreted by best professional judgement. Flood tidal shoals tend to be dominated by an amphipod and polychaete infaunal community whose structure depends on the magnitude of tidal currents and waves. Flood tidal shoals occasionally support submerged aquatic vegetation (SAV), with its associated high aquatic habitat value, on their leeward side.

(5) *tidal creeks and flats*. Areas within tidal creeks that had filled with emergent or shallow sand shoals were classified in this microhabitat. Tidal creeks were present on the estuarine portion of barrier islands or within estuarine marsh complexes. Sandy intertidal or shallow flats contiguous with the estuarine shoreline were also placed in this category. This microhabitat represents a quieter foraging environment with proximity to fauna found in muddy substrates (i.e., adjacent marshes), small fish, crustaceans, shellfish, etc.

(6) *overwash-dominated beach*. Sections of barrier islands, generally those devoid of

development, where overwash processes dominate the distribution of bare sand habitats were categorized as overwash-dominated beach. These areas were defined by overwash terraces, fans and flats that penetrated the visible dune line or stable vegetation. Some overwash-dominated beach reaches extended from the oceanfront to the sound shoreline. Inlets that had recently closed were placed in this category because tidal influences were no longer present. This microhabitat predominantly represents nesting habitat.

Using the Geographic Information System (GIS) software ArcView 3.2a, the microhabitats were digitally traced where they occurred along the barrier islands and tidal inlets along the Atlantic Ocean. The spatial area (in acres) of each microhabitat was tabulated for each barrier island and inlet where habitat was present. Best professional judgement and experience with each location surveyed served as a ground-truthing of conditions present during 1998. The digital boundaries between microhabitats were traced at a 1:4000 scale with an estimated accuracy of ±10 feet. Acreage calculations are conservative given the different days and tidal stages of adjacent images.

Table D-1 lists the total of all six microhabitats for each tidal inlet complex, in order of decreasing acreage. Table D-2 lists the specific microhabitat acreage for each closed inlet location (for inlets closed within the last 40 years), again in decreasing abundance. Table D-3 provides the total acreage for overwash-dominated beach habitats. The final table, Table D-4, summarizes the coverage of each microhabitat for each geographic area, proceeding from south to north along the North Carolina coast.

Table D-1. Total area at each inlet complex within the six microhabitat categories, listed in order of decreasing area. See Table D-4 for a break-down of the areas within each microhabitat.

Inlet Complex	Area (acres)
Ocracoke	1176.72
New Drum	772.20
Oregon	670.88
Cape Fear River[1]	627.98
New River	560.16
Beaufort	462.78
Barden	446.52
Bogue	436.76
New Topsail	433.65
Hatteras	431.79
Bear	283.07
Hog	209.93
Shallotte[2]	136.71
Tubbs	133.15
Mason	105.12
Brown	100.41
Lockwood's Folly	91.18
Rich	89.42
Little River	87.42
Carolina Beach	76.78
Masonboro	45.67

[1] Note the totals for the Cape Fear River mouth include habitat on or adjacent to Battery Island.
[2] Note the totals for Shallotte Inlet are incomplete due to an unavailable quarter-quad of 1998 color-infrared aerial imagery.

Table D-2. Total identifiable area at each closed inlet complex within the six microhabitat categories, listed in order of decreasing area. The year in which the inlet closed and whether the inlet closed naturally or artificially is also listed. See Table D-4 for a break-down of the areas within each microhabitat.

Closed Inlet Complex	Year Inlet Closed	Type of Closure	Area (acres)
New (Corncake)	1998-99	Natural	249.24
Old Topsail	1998	Natural	159.64
Mad	1997	Natural	71.61
Old Drum	1998	Natural	0
Moore's	1965	Artificial	0
Buxton	1963	Artificial	0

Table D-3. Locations with significant overwash-dominated beach microhabitat, listed in order of decreasing abundance.

Location	Area (acres)
Portsmouth Island	3228.25
Core Banks	821.57
Shackleford Banks	459.64
Masonboro Island	401.75
Cape Lookout	328.41
Smith Island (area south of New/Corncake Inlet)	295.77
Fort Fisher (area north of New/Corncake Inlet)	226.52
Cape Hatteras	206.42
Lea Island	98.50
Carolina Beach	69.49
Hutaff Island	69.08
Cape Fear	19.91

Table D-4. The spatial coverage of each microhabitat for each location surveyed between the Virginia-North Carolina state line and Hog Inlet, South Carolina. The locations are presented from south to north.

	Microhabitat						
Location	Flood tidal shoals	Ebb tidal shoals	Dry inlet shoulder	Wet inlet shoulder	Tidal creek shoals/flats	Overwash-dominated beach	Total
Hog Inlet	18.32	5.33	14.33	56.71	3.19	112.05	209.93
Little River Inlet	70.96	0	11.87	4.59	0	0	87.42
Mad Inlet (closed)	0	0	0	0	0	71.61	71.61
Tubbs Inlet	66.97	4.19	5.93	47.63	8.43	0	133.15
Shallotte Inlet[1]	0	28.21	32.68	29.83	0	45.99	136.71
Lockwood's Folly Inlet	12.3	0	42.58	36.3	0	0	91.18
Cape Fear River[2]	467.93	46.43	47.47	47.06	19.09	0	627.98
Cape Fear	0	0	0	0	0	19.91	19.91
Smith Island	0	0	0	0	0	295.77	295.77
New Inlet (closed)	10.17	0	0	0	0	239.07	249.24
Fort Fisher	0	0	0	0	0	226.52	226.52
Carolina Beach	0	0	0	0	0	69.49	69.49
Carolina Beach Inlet	0	1.49	51.69	20.57	3.03	0	76.78
Masonboro Island	0	0	0	0	0	401.75	401.75

Location	Flood tidal shoals	Ebb tidal shoals	Dry inlet shoulder	Wet inlet shoulder	Tidal creek shoals/flats	Overwash-dominated beach	Total
Masonboro Inlet	21.75	0	19.33	4.59	0	0	45.67
Moore's Inlet (closed)	0	0	0	0	0	0	0
Mason Inlet	36.84	0	(inc. in overwash category)	(inc. in overwash category)	0	68.28	105.12
Rich Inlet	35.23	0	37.02	17.17	0	0	89.42
Lea Island	0	0	0	0	0	98.5	98.5
Old Topsail Inlet (closed)	99.3	0	0	0	19.69	40.65	159.64
Hutaff Island	0	0	0	0	0	69.08	69.08
New Topsail Inlet	189.75	31.81	83.74	52.17	76.18	0	433.65
New River Inlet	48.69	50.57	54.11	55.02	0	351.77	560.16
Brown Inlet	5.29	0	26.25	30.58	0	38.29	100.41
Bear Inlet	119.62	31.51	47.5	71.06	13.38	0	283.07
Bogue Inlet	175.67	45.62	103.05	83.54	28.88	0	436.76
Beaufort Inlet	227.26	0	43.77	79.04	112.71	0	462.78
Shackleford Banks	0	0	0	0	142.38	317.26	459.64
Barden Inlet	160.37	17.37	22.11	86.23	160.44	0	446.52
Cape Lookout	0	0	0	191.65	0	136.76	328.41
Old Drum Inlet (closed)	0	0	0	0	0	0	0

Location	Flood tidal shoals	Ebb tidal shoals	Dry inlet shoulder	Wet inlet shoulder	Tidal creek shoals/flats	Overwash-dominated beach	Total
Core Banks	0	0	0	0	408.81	412.76	821.57
New Drum Inlet	472.88	0	95.89	192.45	10.98	0	772.2
Portsmouth Island	0	0	0	0	2523.09	705.16	3228.25
Old Drum Inlet[3]	0	0	0	0	0	0	0
Ocracoke Inlet	621.4	29.18	129.57	396.57	0	0	1176.72
Hatteras Inlet	215.35	0	110.55	105.89	0	0	431.79
Cape Hatteras	0	0	0	45.87	0	160.55	206.42
Buxton Inlet (closed)	0	0	0	0	0	0	0
Oregon Inlet	401.1	0	71.59	198.19	0	0	670.88
TOTALS	**3477.15**	**291.71**	**1051.03**	**1852.71**	**3530.28**	**3881.22**	**14,084.10**

[1] Note the totals for Shallotte Inlet are incomplete due to an unavailable quarter-quad of 1998 color-infrared aerial imagery.
[2] Note the totals for the Cape Fear River mouth include habitat (classified as flood tidal shoal microhabitat) on or adjacent to Battery Island.
[3] Note that Old Drum Inlet had closed and no longer had a distinctive geomorphology by the time of the 1998 imagery. The inlet re-opened in 1999 during Hurricanes Dennis and Floyd.